STUDY OF MORPHOLOGY OF HUNDRED

DRY HUMAN MANDIBLES

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CERTIFICATE

This is to certify that this dissertation titled **" STUDY OF MORPHOLOGY OF HUNDRED DRY HUMAN MANDIBLES"** is a bonafide research work of **DR.S.BHARATHI RANI**, a student in M.D. Anatomy, Branch XXIII in partial fulfilment of the requirements for the award of MD degree by The Tamilnadu Dr. M.G.R. Medical university.

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DECLARATION

I, **DR.S.BHARATHI RANI**, solemnly declare that the dissertation titled **" STUDY OF MORPHOLOGY OF HUNDRED DRY HUMAN MANDIBLES"** has been prepared by me.

This is submitted in partial fulfilment of the regulations for the award of MD Anatomy degree examination to be held in April 2012.

This work has not formed the basis for the award of any other degree or diploma to me previously from any other university.

Place: Madurai **DR.S.BHARATHIRANI**

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MORPHOLOGY OF HUNDRED DRY HUMAN MANDIBLES

ABSTRACT:

AIM:

To study the morphology and morphometry of mandible in hundred dry specimens.

MATERIALS AND METHODS:

Hundred dry human mandibles were selected randomly irrespective of age and sex. Defective and broken specimens, totally edentulous mandibles were excluded from the study. Using Digital vernier caliper, the following parameters were measured and analysed- Bigonial width, height of the ramus, maximum breadth of the ramus, minimum breadth of the ramus, symphyseal height and Mental foramen- it's distance from lower border of mandible, situational variability, accessory foramen.

RESULTS:

Bigonial width, height of the ramus, maximum breadth of the ramus, minimum breadth of the ramus, and the symphyseal height showed significant sexual dimorphism. Only 3% of the mandibles cannot be sexually categorised considering bigonial width and maximum breadth of the ramus whereas 23% could not be categorised using height of the ramus, minimum breadth of the ramus and symphyseal height.

In 73 to 74 % mandibles the distance of the mental foramen from the lower border of the mandible was found to be within the normal range of 13–15 mm on both sides. Only 6-7% showed extreme deviation with a minimum of 9.4mm and a maximum of 17.1 mm. Accessory foramen was found mostly on the left side and only one showed accessory foramen on right side.

Bilaterally absent mental foramen, an extremely rare variation was also seen .

CONCLUSION:

This study may be helpful to the maxillofacial surgeons and anthropologists for identification of different populations and also to identify the unnoticed variations of the mental foramen which is essential to prevent the neurovascular complications in the mental region.

INTRODUCTION

Mandible is the largest, hardest and the most durable bone of the skull, which has various morphological features which show changes with reference to age, sex and race.

The mandible is a Latin word which means lower jaw that serves for the reception of the lower teeth and gives insertion to the muscles of mastication. It is the only movable bone of the skull articulating with the temporal bone at the synovial temporo - mandibular joint.

In the present forensic scenario, dismemberment or mutilation of the body has become the frequent method to conceal the identity of the victim. Thus, identification of human skeletal remains becomes important. When entire adult skeleton is available for analysis, identification is relatively easy , but in cases of mass disasters where usually fragmented bones are found, identification becomes very difficult with the available parts of skeletal remains.

In such cases, sex determination using bone fragments makes identification easier. Even though this can be done with almost every bone of the human skeleton, past studies indicate that skull is the most dimorphic and easily sexed portion of skeleton after pelvis, providing accuracy up to 92% . But in cases where intact skull is not found, mandible can be considered as it is a component of the skull.

In addition , due to the close proximity of many neuro-vascular structures to the mandible, knowledge of the morphological features of the mandible such as the mental foramen, ramus of mandible , becomes important for the oral and maxillofacial surgeons in all aspects of reconstructive cranio-maxillo-facial surgeries.

As mental foramen is an important landmark for various surgical procedures, anaesthetic interventions , soft tissue exicisions and biopsy, knowledge of its morphology becomes important not only for maxillofacial surgeons, but also for all medical professionals. Hence, this study was made.

AIM OF THE STUDY

To study the morphology and morphometry of mandible in hundred dry specimens.

REVIEW OF LITERATURE

The significant research investigations and articles on various morphological features of the mandible are reviewed briefly in the literature.

Ruck [1932] [39] while studying the structure of the mandible recorded that the males possess V shaped mandible and the females U shaped.

Earliest studies on mandible by Morant et al. [1936][31], Martin [1936][30], and Hrdlicka [1940][21] , have established the usefulness of mandible for determination of sex. They found that the sexual differences were highest in height of the ramus.

Hrdlicka [1940][21] studied about bigonial breadth and gonial angle of human mandible and was able to obtain 80 percent accuracy of sex with adult skull and 90 percent with skull and mandible.

Krogman [1962][26] noted morphological differences of mandibles from white and black races. The mandibles from the white race have high narrower ramus, greater bigonial breadth,

high corpus which is relative to bigonial breadth, a more protrusive chin. But the mandibles from the black race have lower wider ramus, relatively smaller breadth dimensions, less dominant chin.

Aitchison [1963] [1] suggested that developmental stages and growth rates of male and female mandibles are different since males reach puberty later than females. Hence the surfaces of the mandibles of males are often rough, whereas those of females tend to be smooth.

Lordanidis [1963][28] studied sexual differences in 300 skeletons and recorded percentage certainty of sex with each skeletal remains for 15 bones. Among them mandible constituted 26.24% .

Giles [1964][14] reported mandibular ramus height, maximum ramus breadth, and minimum ramus breadth as highly significant with classification accuracy of 85% in American whites and Negroes.

Lockhart et al., [1965][27] reported that eversion of the angle of mandible is characteristic of males while inversion is characteristic of females.

Malik [1969][29] documented that the male mandible has greater symphyseal height and greater breadth of ascending ramus compared to female mandibles.

In [1970][24] Kadanoff et al demonstrated the variations in the number of mental foramina ranging from being absent to double or triple, equal or unequal sized; close or widely separate or even multiple; in the form of a cluster.

Heerreshchandra and Maliviya [1972][20] studied 27 adult female bones of known sex and concluded that the round chin mandible with inversion or eversion cannot be a female one.

De Freitas V, Madeira MC [1979][6]observed absent foramen twice in the right side (0.06%) and once in the left side (0.03%).

Brothwell [1981][4] recorded that male mandible is more robust with well developed and flaring gonial regions , broader and longer ramus and well developed coronoid process.

Gershenson et al. [1986][13] who examined 525 dry mandibles focusing on variation, shape and site of the mental foramen related to the teeth, reported that 4.3% mandibles had double mental foramina, and 0.7% mandibles had triple mental foramina. Finally they found one mandible that had four mental foramina on one side (0.1%) .

Surendranath [1989][49] described that males have higher symphyseal height and broader ascending ramus, while females have lower symphyseal height and less diameter of ramus.

Serman [1989][43] examined 408 dry human mandibles and found one extra foramen on one side in seven mandibles constituting 1.7% and in two specimens bilateral double mental foramina. Altogether eleven double mental foramina were documented on 408 mandibular specimens (2.7%) .

Singh et al [1992] [45] found that the mean distance of mental foramen from the lower border of mandible was 14 mm.

Danny.R. in [1998][5] , demonstrated accessory mental foramen to be more frequent in Nazca, African Americans and less

common in Asian Indians and American Whites.

Sawyer et al [1998][41] reported presence of accessory mental foramen in four ethnic groups to be 5.6% and the maximum number found in any population was two .

Parikh [1999][35] documented that increased symphyseal height, more broad ramus, and everted angle were characteristic of male whereas decreased symphyseal height, less broad ramus,and inverted angle were characteristic of female.

Humphrey et al. [1999][22] pointed out that during growth mandibular ramus and condyle are the sites, which are associated with greatest morphological changes in size and remodeling, hence most dimorphic.

K. Fanibunda and N.S Mathews [1999][9] studied about the relationship between accessory foramina and tumour spread on the lateral mandibular surface .

Ngeow [2003][33] observed that the position of the mental foramen was type -4 in 69.2% of the mandibles and type -3 in 19.6% of the mandibles.

In Thailand, Stithipon [2005][48] and his colleagues studied 110 mandibles and found only two (1.8%), that had double mental foramina .

Rajaram .V. (2006)[36] reported a double mandibular foramen in a mandible of the south Indian population.

Kim [2006][25] , Apinhasmit et al [2006][2] observed that the mean distance of the mental foramen from the mandible was 14.33 mm and 14.88 mm respectively.

Franklin et al. [2006][11]reported that in South African blacks, the regions of mandible expressing the greatest sexual dimorphism are condyle and ramus. In their study, ramus height showed 87.5%. average accuracy of sex determination.

Gingor from Turkey [2006][15] has shown that the most common position of the mental foramen was between the two

premolars (Type -3) in 71.5% cases.

Fabian [2007][8]reported that the position of the mental foramen is type -4 in 45% of the mandibles and type -5 in 35% of the mandibles.

Dayal et al. [2008][7]found that the mandibular ramus height is the best parameter for sex determination in their study with 75.8% accuracy.

Yesilyurt et al [2008][51] observed that the mean distance of mental foramen from the lower border of mandible was 9.4 mm on both sides and the most common positions for the mental foramen were below the second premolar tooth (Type 4) in 55-60% and between the premolars (Type 3) in 26-34% .

Haghanifar and Rokouei [2009][17] in their radiological study of the mental foramen, reported that the most common position of the mental foramen was between the two premolars (Type 3), it being 47.2%.

Ilayaperuma et al [2009][23] found that the position of the

mental foramen in relation to the lower teeth was type 4 in 52.94 % of the mandibles and type -3 in 26.47% of the mandibles.

Hasan T, Fauzi M, Hasan D [2010][19] reported an extremely rare anatomical variation of bilaterally absent mental foramen.

Nandy Apurba [2010][32] pointed out that males have everted angle, more symphyseal height and broader ascending ramus whereas females have inverted angle, less symphyseal height, narrow ascending ramus.

Ongkana N, Sudwan P [2010][34] reported in their study that the straight gonial angle was predominant in 50% of females whereas gonial eversion in 50.0% of males.

Siddiqui AU, Daimi SR, Mishra PP, Doshi SS, Date JY, Khurana G. [2011][44] reported that the most common position of the foramen as related to the lower set of teeth was in line with the 2nd premolar (Type-4) and the mean distance from lower border of mandible was 9.9 mm on right side and 9.46 mm on left side.

Saini V., Srivastava R., [2011][40] reported that the mean values for ramus height is 57.56 mm, maximum ramus breadth is 41.58 mm, minimum ramus breadth is 30.47 mm .Values above the mean were considered as males and below the mean as females.

Rajat Mangla, Navjot Singh, Vinay Dua [2011][37] found that mean symphysis height in the female sample being smaller than in the male sample, males having greater ramus height and width.

Gagan Thakur, Shaji Thomas, Sumeeth Cyriac Thayil, Preeti P Nair[2011][12] observed recurrence of pain in a patient after undergoing peripheral neurectomy for trigeminal neuralgia. This was due to the failure to do neurectomy of mental nerve branch coming out of accessory foramen.

FIG – 1: DIGITAL VERNIER CALIPER

MATERIALS AND METHODS

MATERIALS:

The present study was undertaken in hundred dry human mandibles which were randomly selected irrespective of age and sex. Defective and broken specimens were excluded from the study. Totally edentulous mandibles with absorbed alveolar margins were excluded from this study. The bones were numbered from 1 to 100 and each mandible was analysed separately.

INSTRUMENT USED:

The parameters were measured with the help of a Digital Vernier calliper (Fig – 1). A caliper is a device used to measure the distance between two opposing sides of an object. A caliper can be as simple as a compass with inward or outward - facing points. The tips of the caliper are adjusted to fit across the points to be measured, the caliper is then removed and the distance read by measuring between the tips with a measuring

tool, such as a ruler. A refinement now popular is the replacement of the analog dial with an electronic digital display on which the reading is displayed as a single value.

METHOD OF STUDY

In the present study, the following parameters were measured and analysed .

1. Bigonial width :

Bigonial width measures the maximum distance between the two gonia .

2. Height of the ramus :

It measures the distance between the highest point on the mandibular condyle and the most prominent point of the inferior border of the ramus, which was measured both on right and left sides .

3. Maximum breadth of the ramus :

The distance between the most anterior point on the mandibular ramus and a line connecting the most posterior point on the condyle and the angle of jaw.

4 . Minimum breadth of the ramus :

It is the smallest anterior–posterior diameter of the ramus .

5. Symphyseal height :

It measures the distance between two points named infradentale and gnathion.

- Infradentale – Midpoint of a line tangential to the outer margin of the two mandibular central incisor teeth.
- Gnathion – It is the lowest point on chin. The middle point of the lower border of the mandible in the sagittal plane.

6. Mental foramen :

- distance from the lower border of mandible
- situational variability
- presence of accessory foramen

A. Distance from the lower border of mandible :

The distance from the inferior margin of mental foramen to the lower border of mandible was measured.

B. The situational variability of the mental foramen was recorded.

The relation of mental foramen with the lower teeth (the position of the mental foramen was recorded as lying in line with the long axis of a tooth or interdental space) was classified in one of the following positions (Tebo & Telford, 1950) [50]

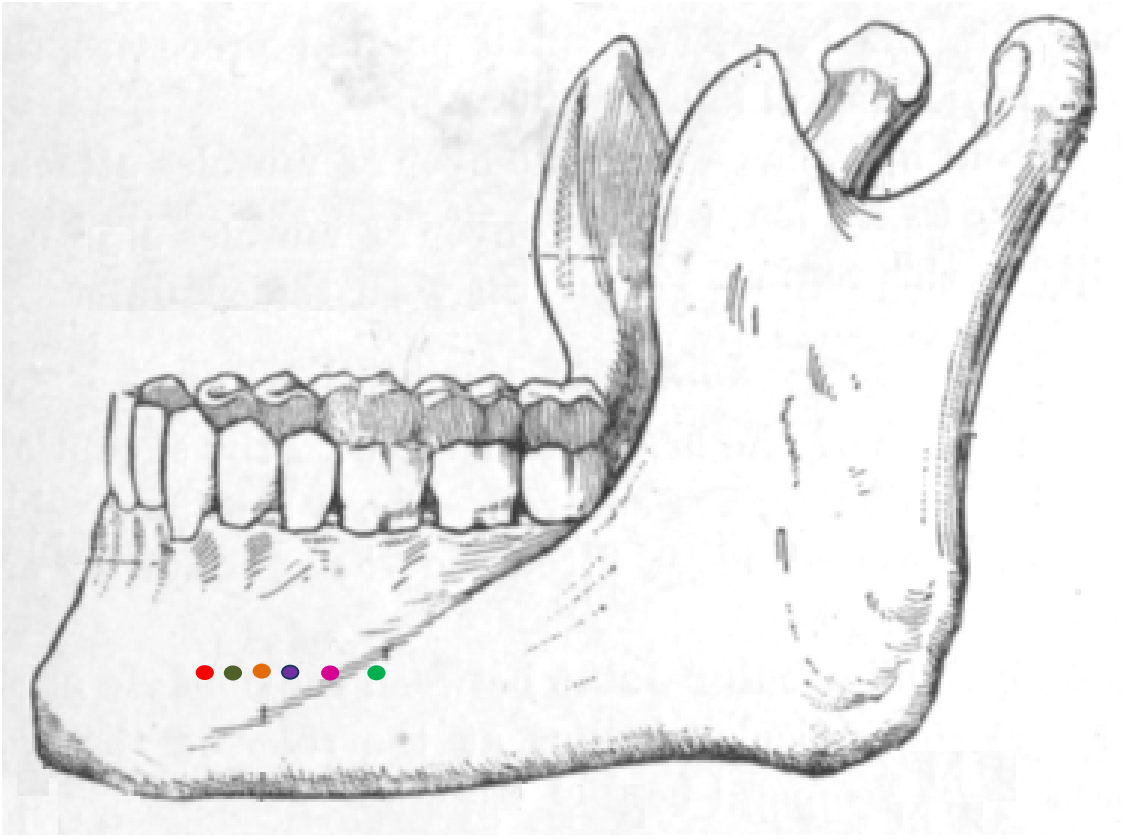


Figure 2 : situational types of mental foramen (Tebo & telford)

- Type 1 - Anterior to the first premolar
- Type 2 - Below the first premolar
- Type 3 - Between the premolars
- Type 4 - Below the second premolar
- Type 5 - Posterior to the second premolar
- Type 6 - Below the first molar

- C. Accessory foramen – present or absent

FIG – 3: SPECIMEN OF HUMAN MANDIBLE

ANATOMY OF THE MANDIBLE :

The mandible or the lower jaw is the largest and strongest bone of the face, serves for the reception of the lower teeth. It consists of three parts - a curved, horizontal portion, the body, and two perpendicular portions, the rami, which unite with the ends of the body nearly at right angles.

The Body(corpus mandibulae) :

The body is curved somewhat like a horseshoe and has two surfaces and two borders.

Surfaces:

The external surface is marked in the median line by a faint ridge, indicating the symphysis menti. This ridge divides below and encloses a triangular eminence, the mental protuberance, the base of which is depressed in the center but raised on either side to form the mental tubercle. On either side of the symphysis, just below the incisor teeth, is a depression, the incisive fossa.

Below the second premolar tooth, on either side, midway between the upper and lower borders of the body, is the

mental foramen, for the passage of the mental vessels and nerve. The mental foramen lies either below the interval between the premolar teeth, or below the second premolar tooth. The posterior border of the foramen is smooth and accommodates the nerve which emerges postero laterally. On each side, mental foramen is located on the buccal cortex of mandibular bone and lies near the apices of the premolars. It has been shown to be located at 13-15 mm above the inferior border of mandible and transmits the mental nerve and vessels. The mental nerve is the terminal branch of the inferior alveolar nerve and gives sensory innervations to lower lip, buccal vestibule and the gingiva medial to the first mandibular molar. Running backward and upward from each mental tubercle is a faint ridge, the oblique line, which is continuous with the anterior border of the ramus.

The internal surface : is concave from side to side and has following features. Extending upward and backward on either side from the lower part of the symphysis to third molar teeth is the mylohyoid line. Above the anterior part of this line is the

sublingual fossa, and below the posterior part, an oval submandibular fossa.

Posterior surface of symphysis menti presents elevations called genial tubercles or mental spines.

Borders

The superior or alveolar border bears sockets for the roots of teeth of lower jaw. The inferior border is called base of mandible and has a depression just anterior to the angle of mandible called as antegonial notch.

The Ramus (ramus mandibulae; perpendicular portion)

The ramus is quadrilateral in shape, and has two surfaces, four borders, and two processes.

Surfaces:

The lateral surface is flat and marked by oblique ridges at its lower part.

The medial surface presents about its center the oblique mandibular foramen, for the entrance of the inferior alveolar vessels and nerve.

The margin of this opening is irregular; it presents in front a prominent ridge, surmounted by a sharp spine, the lingula, which gives attachment to the spheno mandibular ligament; at its lower and back part is a notch from which runs the mylohyoid groove which lodges the mylohyoid vessels and nerve. The mandibular canal runs obliquely downward and forward in the ramus, and then horizontally forward in the body, where it is placed under the alveoli and communicates with them by small openings. On arriving at the incisor teeth, it turns back to communicate with the mental foramen, giving off two small canals which run to the cavities containing the incisor teeth. In the posterior two-thirds of the bone the canal is situated nearer the internal surface of the mandible; and in the anterior third, nearer its external surface. It contains the inferior alveolar vessels and nerve, from which branches are distributed to the teeth.

Borders

The lower border of the ramus is thick, straight, and continuous with the inferior border of the body of the bone. At its junction with the posterior border is the angle of the mandible or the gonial angle or the gonia, which may be either inverted or everted and the stylo mandibular ligament is attached to the angle.

The anterior border is thin above, thicker below, and continuous with the oblique line. The posterior border is thick, smooth, rounded and covered by the parotid gland. The upper border is thin, and is surmounted by two processes.

Processes

The coronoid in front and the condyloid behind, separated by a deep concavity, the mandibular notch.

The Coronoid Process is a thin, triangular eminence, which is flattened from side to side and varies in shape and size. Its anterior border is convex and is continuous below with the

anterior border of the ramus; its posterior border is concave and forms the anterior boundary of the mandibular notch.

The Condyloid Process is thicker than the coronoid, and consists of two portions: the condyle, and the constricted portion which supports it, the neck. The condyle presents an articular surface for articulation with the articular disk of the temporo mandibular joint; it is convex from before backward and from side to side, and extends farther on the posterior than on the anterior surface. Its long axis is directed medial ward and slightly backward, and if prolonged to the midline will meet that of the opposite condyle near the anterior margin of the foramen magnum.

The mandibular notch, separating the two processes, is a deep semilunar depression, crossed by the masseteric vessels and nerve.

Development of the mandible

The body of the mandible

The mandible is ossified in the fibrous membrane covering the outer surfaces of Meckel's cartilages. These cartilages form the cartilaginous bar of the mandibular arch and are two in number, a right and a left. Their proximal or cranial ends are connected with the ear capsules, and their distal extremities are joined to one another at the symphysis by mesodermal tissue.

Meckel's cartilage has a close, relationship to the mandibular nerve, at the junction between posterior and middle thirds, where the nerve divides into the lingual and inferior dental nerve.

From the proximal end of each cartilage , two of the bones of the middle ear, are developed; the next succeeding portion, as far as the lingula, is replaced by fibrous tissue, which persists to form the spheno mandibular ligament and the perichondrium of the cartilage persist as spheno mallular ligament, malleus and incus. Between the lingula and the canine tooth the cartilage disappears,

while the portion of it below and behind the incisor teeth becomes ossified and incorporated with this part of the mandible.

The rami of the mandible

The ramus of the mandible develops by a rapid spread of ossification backwards into the mesenchyme of the first branchial arch diverging away from Meckel's cartilage. This point of divergence is marked by the mandibular foramen.

Somewhat later, accessory nuclei of cartilage make their appearance: a wedge-shaped nucleus in the condyloid process and extending downward through the ramus as a small strip along the anterior border of the coronoid process

The condylar cartilage: Carrot shaped cartilage appears in the region of the condyle and occupies most of the developing ramus. It is rapidly converted to bone by endochondral ossification by 14^{th} week of intrauterine life . It gives rise to: Condyle head and neck of the mandible and also the posterior half of the ramus to the level of inferior dental foramen.

The coronoid cartilage: It is relatively transient growth cartilage center which appears by 4th - 6th month of intrauterine life. It gives rise to: Coronoid process and the anterior half of the ramus to the level of inferior dental foramen.

These accessory nuclei possess no separate ossific centers, but are invaded by the surrounding membrane bone and undergo absorption.

The alveolar process

It starts when the deciduous tooth germs reach the early bell stage. The bone of the mandible begins to grow on each side of the tooth germ. By this growth the tooth germs come to be in a trough or groove of bone, which also includes the alveolar nerves and blood vessels.

Later on, septa of bone between the adjacent tooth germs develop, keeping each tooth separate in its bony crept. The mandibular canal is separated from the bony crypts by a horizontal plate of bone. The alveolar processes grow at a rapid rate during the periods of tooth eruption.

FIG –4: THE HUNDRED SPECIMENS OF THE PRESENT STUDY

OBSERVATIONS

Using the Digital Vernier caliper, one hundred dry mandibles were studied. Datas were collected, recorded and tabulated .

The collected Data's are as follows:

- Bigonial width
- Height of the ramus
- Maximum breadth of the ramus
- Minimum breadth of the ramus
- Symphyseal height
- Mental foramen

Bigonial width :

The bigonial width was measured in hundred dry mandibles and the recorded values were tabulated .

BIGONIAL WIDTH

Table 1. Bigonial Width

Specimen No	Bigonial Width (mm)
1	106.7
2	94.2
3	84.1
4	92 .3
5	88.1
6	81 .2
7	81 .1
8	82 .2
9	94.1
10	82.3
11	91.2
12	85 .1
13	98.2
14	81 .3
15	75.5
16	80 .2
17	94.1
18	93.2
19	82 .4
20	83 .1
21	88.8
22	84.2
23	82 .1
24	95 .3
25	81 .2

Specimen no	Bigonial Width (mm)
26	93.2
27	92.2
28	81.3
29	82.1
30	102.8
31	82.7
32	100.8
33	88.6
34	95.4
35	83.2
36	93.4
37	99.3
38	86.3
39	99.3
40	82.2
41	92.4
42	89.1
43	96.5
44	79.2
45	101
46	89.2
47	94.3
48	83.4
49	92.1
50	93.2

BIGONIAL WIDTH

Table 2. Bigonial Width

Specimen no	Bigonial Width (mm)
51	95.5
52	97.2
53	90.1
54	79.6
55	84.4
56	100.3
57	89.3
58	84.6
59	99.4
60	87.7
61	95.8
62	89.1
63	88.4
64	90
65	97.3
66	87.6
67	97.8
68	81.2
69	77.4
70	83.2
71	92.4
72	98.6
73	98.1
74	79.3
75	97.4

Specimen no	Bigonial Width (mm)
76	96.5
77	87.1
78	80.5
79	103.2
80	98.2
81	87.4
82	92.3
83	92.1
84	95.4
85	99.3
86	87.2
87	98.3
88	91.62
89	100.2
90	95.2
91	86.4
92	93.3
93	86.3
94	97.1
95	96.1
96	94.2
97	85.2
98	100.4
99	98.2
100	88.6

FIG -5 : BIGONIAL WIDTH -

MAXIMUM (1) AND MINIMUM (15)

From the above observations, it is evident that the maximum bigonial width of 106.7 mm is recorded in specimen one. (Fig - 5).

The minimum width of 75.5 mm has been recorded in specimen 15 (Fig - 5) .

Height of the ramus :

The height of the ramus of hundred mandibles was measured on right and left sides and the values were tabulated.

HEIGHT OF THE RAMUS

Table 3. Height of the Ramus

Specimen No	Right Side(mm)	Left Side(mm)
1	61.2	61.2
2	62.1	62.1
3	56.3	56.3
4	66.2	66.2
5	68.1	68.1
6	66.3	66.3
7	57.2	57.2
8	58.2	58.2
9	60.6	60.6
10	45.2	45.2
11	62.2	62.2
12	49.4	49.4
13	54.1	54.1
14	58.3	58.3
15	55.4	55.4
16	56.1	56.1
17	60.2	60.2
18	60.3	60.3
19	59.5	59.5
20	52.2	52,2
21	54.1	54.1
22	51.8	51.9
23	62.2	62.2
24	61.4	61.4
25	59.4	59.5

Specimen no	Right Side(mm)	Left Side(mm)
26	62.1	62.1
27	59.6	59.2
28	54.5	54.5
29	55.2	55.2
30	66.1	66.1
31	55.2	55.2
32	58.2	58.2
33	58.4	58.4
34	57.2	57.2
35	59.5	59.5
36	73.8	73.8
37	65.6	65.6
38	54.6	54.6
39	62.7	62.7
40	55.2	55.2
41	62.1	62.1
42	55.5	55.5
43	67.3	67.3
44	47.2	47.2
45	65.1	65.1
46	59.4	59.5
47	70.4	70.1
48	49.2	49.1
49	64.3	64.3
50	63.3	63.1

HEIGHT OF THE RAMUS

Table 4. Height of the ramus

Specimen no	Right Side(mm)	Left Side(mm)
51	69.4	69.2
52	66.2	66.1
53	54.4	54.3
54	50.6	50.2
55	59.6	59.4
56	71.5	71.5
57	58.2	58.3
58	58.5	58.5
59	70.6	70.2
60	58.4	58.4
61	63.8	63.8
62	58.3	58.3
63	58.4	58.4
64	65.0	65.0
65	62.7	62.7
66	50.2	50.2
67	64.3	64.3
68	57.2	57.2
69	50.3	50.3
70	59.5	59.5
71	63.3	63.3
72	67.2	67.2
73	64.1	64.1
74	62.1	62.1
75	64.3	64.3

Specimen no	Right Side (mm)	Left Side (mm)
76	68.0	68.0
77	58.4	58.4
78	50.2	50.2
79	59.4	59.4
80	54.2	54.2
81	52.3	52.3
82	64.2	64.2
83	64.1	64.1
84	66.2	66.1
85	68.3	68.1
86	61.2	61.2
87	61.1	61.4
88	65.2	65.2
89	66.2	66.2
90	68.2	68.2
91	59.4	59.4
92	65.4	65.2
93	57.4	57.5
94	62.2	62.3
95	59.8	59.6
96	53.2	53.2
97	50.8	50.8
98	61.4	61.5
99	62.2	62.5
100	63.4	63.4

FIG – 6: HEIGHT OF THE RAMUS

MAXIMUM (36) AND MINIMUM (10)

The maximum height of the ramus observed was 73.8 mm in specimen 36 on both sides. (Fig - 6)

The minimum height recorded was found to be 45.2 mm in specimen 10 on both sides. (Fig - 6)

Maximum breadth of the ramus :

The maximum breadth of the ramus was measured in hundred mandibles on right and left sides and the measured values were tabulated .

MAXIMUM BREADTH OF THE RAMUS

Table 5 .Maximum breadth of the ramus

Specimen No	Right Side (mm)	Left Side (mm)
1	41.4	41.4
2	42.3	42.3
3	37.4	37.4
4	40.2	40.2
5	37.4	37.4
6	41.11	41.11
7	45.6	45.6
8	38.1	38.1
9	38.01	38.01
10	34.4	34.4
11	41.6	41.6
12	35.6	35.6
13	45.2	45.2
14	36.2	36.2
15	30.4	30.4
16	37.9	37.9
17	42.5	42.5
18	39.12	39.12
19	43.8	43.8
20	35.2	35.2
21	38.2	38.2
22	37.1	37.1
23	34.2	34.2
24	43.4	43.4
25	41.6	41.6

Specimen no	Right Side (mm)	Left Side (mm)
26	40.4	40.4
27	38.2	38.2
28	37.1	37.1
29	42.3	42.3
30	42.9	42.9
31	43.1	43.1
32	38.2	38.4
33	36.9	36.9
34	37.9	37.9
35	42.2	42.2
36	41.2	41.2
37	34.2	34.2
38	40.9	40.9
39	40.6	40.4
40	33.2	33.2
41	36.2	36.2
42	32.2	32.2
43	41.4	41.4
44	37.2	37.2
45	42.4	42.4
46	40.2	40.2
47	43.4	43.4
48	38.1	38.1
49	42.4	42.4
50	40.2	40.2

MAXIMUM BREADTH OF THE RAMUS

Table 6. Maximum breadth of ramus

Specimen No	Right Side (mm)	Left Side (mm)
51	45.2	45.2
52	44.3	44.3
53	40.1	40.1
54	34.6	34.6
55	37.6	37.6
56	34.2	34.2
57	38.1	38.1
58	38.4	38.6
59	46.2	43.2
60	37.7	37.7
61	42.2	42.2
62	38.4	38.4
63	36.8	36.8
64	31.9	31.9
65	41.7	41.7
66	37.2	37.2
67	42.1	42.1
68	35.2	35.2
69	37.1	37.1
70	42.6	42.6
71	41.9	41.9
72	47.2	47.2
73	44.2	44.2
74	37.7	37.7
75	34.1	34.1

Specimen no	Right Side (mm)	Left Side (mm)
76	33.3	33.3
77	32.6	32.6
78	35.5	35.5
79	45.8	45.8
80	40.5	40.5
81	32.2	32.2
82	45.2	45.2
83	43.2	43.2
84	44.8	44.8
85	31.6	31.6
86	34.9	34.9
87	45.6	45.6
88	43.7	43.7
89	40.82	40.82
90	42.6	42.6
91	45.8	45.8
92	44.32	44.32
93	36.2	36.2
94	43.3	43.3
95	31.3	31.3
96	34.8	34.8
97	36.3	36.3
98	44.8	44.8
99	41.2	41.2
100	36.2	36.2

FIG – 7: MAXIMUM BREADTH OF THE RAMUS

MAXIMUM (72) AND MINIMUM (15)

The highest value recorded for maximum breadth of ramus on both sides is 47.2 mm in specimen 72 (Fig - 7).

The lowest value recorded is 30.4 mm in specimen 15 on both sides (Fig - 7).

Minimum breadth of the ramus:

The minimum breadth of the ramus was measured for hundred mandibles on both sides and the values are tabulated.

MINIMUM BREADTH OF RAMUS

Table 7. Minimum breadth of ramus

Specimen No	Right Side (mm)	Left Side (mm)
1	35.2	35.2
2	36.2	36.2
3	26.2	26.2
4	33.2	33.2
5	27.3	27.3
6	28.2	28.2
7	34.6	34.6
8	29.2	29.2
9	39.2	39.2
10	37.8	37.8
11	31.8	31.8
12	28.8	28.8
13	38.4	38.4
14	26.2	26.2
15	24.8	24.8
16	25.1	25.1
17	38.9	38.9
18	25.2	25.2
19	27.2	27.2
20	26.8	26.8
21	25.4	25.4
22	28.4	28.4
23	30.6	30.6
24	39.4	39.4
25	26.2	26.2

Specimen no	Right Side (mm)	Left Side (mm)
26	33.8	33.8
27	24.9	24.9
28	28.2	28.2
29	34.9	34.9
30	34.8	34.8
31	28.2	28.2
32	24.8	24.8
33	27.4	27.4
34	28.8	28.8
35	34.2	34.2
36	35.2	35.2
37	28.2	28.2
38	26.2	26.2
39	36.4	36.4
40	25.7	25.7
41	30.45	30.45
42	28.2	28.2
43	32.8	32.8
44	24.8	24.8
45	33.6	33.6
46	25.2	25.2
47	34.2	34.2
48	26.2	26.2
49	35.4	35.4
50	36.8	36.8

MINIMUM BREADTH OF RAMUS

Table 8. Minimum breadth of ramus

Specimen no	Right Side (mm)	Left Side (mm)
51	32.2	32.2
52	31.9	31.9
53	26.2	26.2
54	24.8	24.8
55	31.9	31.9
56	24.1	24.1
57	25.6	25.6
58	26.2	26.2
59	34.6	34.6
60	30.53	30.53
61	38.2	38.2
62	24.8	24.8
63	27.9	27.9
64	28.2	28.2
65	36.2	36.2
66	27.4	27.4
67	35.2	35.2
68	24.9	24.9
69	28.3	28.3
70	27.2	27.2
71	32.8	32.8
72	40.3	40.3
73	34.6	34.6
74	39.6	39.6
75	36.2	36.2

Specimen no	Right Side (mm)	Left Side (mm)
76	27.2	27.2
77	28.9	28.9
78	26.2	26.2
79	32.2	32.2
80	25.4	25.4
81	26.2	26.2
82	36.2	36.2
83	35.4	35.4
84	34.6	34.6
85	28.1	28.1
86	25.8	25.8
87	37.8	37.8
88	39.2	39.2
89	27.6	27.6
90	39.3	39.3
91	28.4	28.4
92	38.4	38.4
93	26.7	26.7
94	32.8	32.8
95	34.8	34.8
96	30.49	30.49
97	25.7	25.7
98	39.6	39.6
99	34.8	34.8
100	36.2	36.2

FIG -8: MINIMUM BREADTH OF THE RAMUS

MAXIMUM (72) AND MINIMUM (56)

It is noted that the highest value recorded for minimum ramus breadth is 40.3 mm in specimen 72 on both sides (Fig - 8).

The lowest value recorded is 24.1 mm in specimen 56 on both sides.(Fig -8).

Symphyseal height:

The symphyseal height was measured in hundred mandibles on both sides and the obtained values are tabulated.

SYMPHYSEAL HEIGHT

Table 9. Symphyseal height

Specimen no	Symphyseal height (mm)
1	24.4
2	24.2
3	19.3
4	24.2
5	26.6
6	24.4
7	21.8
8	20.2
9	25.4
10	22.9
11	24.6
12	20.4
13	18.8
14	19.3
15	19.8
16	19.7
17	24.2
18	24.1
19	23.1
20	21.7
21	16.4
22	22.2
23	24.4
24	24.3
25	23.2

Specimen no	Symphyseal height (mm)
26	27.8
27	24.4
28	22.3
29	23.4
30	26.7
31	20.24
32	18.8
33	18.9
34	25.4
35	18.6
36	24.6
37	18.6
38	23.2
39	24.6
40	22.4
41	27.2
42	19.8
43	24.4
44	18.5
45	29.2
46	24.7
47	26.8
48	21.7
49	24.5
50	23.1

SYMPHYSEAL HEIGHT

Table 10. Symphyseal Height

Specimen no	Symphyseal height (mm)
51	24.8
52	24.5
53	21.5
54	21.2
55	23.14
56	27.2
57	21.23
58	18.12
59	28.23
60	23.41
61	24.15
62	18.23
63	20.23
64	23.1
65	24
66	22.2
67	27.6
68	23.1
69	21
70	24.5
71	25.2
72	25.2
73	24.4
74	23.1
75	22.2

Specimen no	Symphyseal height (mm)
76	17.6
77	18.2
78	21.8
79	27.3
80	20.2
81	21.2
82	24.2
83	25.3
84	27.1
85	17.6
86	18
87	26.2
88	29.1
89	25.2
90	26.1
91	23.1
92	26.3
93	22.2
94	30.6
95	20.2
96	20.1
97	22.4
98	26.3
99	27.4
100	18.4

FIG -9 : SYMPHYSEAL HEIGHT

MAXIMUM (94) AND MINIMUM (21)

The above recorded values show a maximal symphyseal height of 30.6 mm in specimen 94 (Fig - 9).

The minimum symphyseal height of 16.4 mm was recorded in specimen 21 (Fig - 9).

Mental foramen

The distance of the mental foramen from the lower border of the mandible was measured on both sides and the recorded values are tabulated.

MENTAL FORAMEN

Table 11.Distance of the mental foramen from the lower border of mandible.

Specimen no	Distance from lower border of mandible(mm)	
	Rt	Lt
1	14.97	15.14
2	14.4	14.53
3	14.22	13.5
4	14.11	14.31
5	14.93	14.93
6	12.34	12.35
7	14.75	14.35
8	14.12	13.88
9	12.56	12.8
10	15.8	15.9
11	13.4	13.28
12	14.8	14.5
13	14.22	13.2
14	13.5	13.6
15	14.8	14.9
16	11.53	11.13
17	14.22	13.5
18	13.2	13.4
19	14.1	12.4
20	15.2	14.8
21	14.3	14.3
22	12.8	12.8
23	12.6	12.6
24	15.8	14.9
25	13.25	11.9

Specimen no	Distance from lower border of mandible(mm)	
	Rt	Lt
26	14.2	14.2
27	14.9	14.8
28	13.5	12.12
29	13.7	14.7
30	13.12	13.45
31	12.82	13.22
32	13.6	13.5
33	14.9	14.9
34	13.8	14.2
35	11.52	11.48
36	12.5	12.5
37	15	15
38	13.2	13.2
39	15.8	14.65
40	14.2	14.2
41	17.1	17.2
42	14.25	14.25
43	16	17.1
44	14.2	14.3
45	14.5	15.5
46	13.8	14.2
47	13.52	13.52
48	14.8	14.7
49	15.4	15.8
50	14.9	15.2

MENTAL FORAMEN

Table 12. Distance of the mental foramen from the lower border of the mandible

Specimen no	Distance from lower border of mandible (mm)	
	Rt	Lt
51	13.8	15.82
52	13.52	13.62
53	13.22	13.32
54	13.2	13.4
55	-	-
56	15.82	14.52
57	13.92	13.82
58	14.2	14.5
59	14.8	14.4
60	13.45	13.45
61	14.82	14.5
62	14.12	14.3
63	12.4	13.24
64	13.4	13.6
65	11.3	11.3
66	14.8	14.6
67	16.2	15.9
68	9.8	12.2
69	9.4	9.5
70	13.6	13.6
71	14.2	13.9
72	13.3	16.2
73	14.2	14.2
74	13.2	13.34
75	13.1	13.2

Specimen No	Distance from lower border of mandible (mm)	
	Rt	Lt
76	16.3	14.9
77	13.95	13.19
78	11.51	13.82
79	13.94	13.54
80	13.8	13.4
81	14.16	14.14
82	14.12	13.82
83	13.2	14.4
84	13.86	13.14
85	13.48	13.2
86	14.82	14.32
87	13.3	13.4
88	10.6	10.7
89	14.7	14.98
90	14.2	14.5
91	13.12	13.45
92	13.34	13.14
93	13.38	14.38
94	13.92	13.24
95	13.32	13.52
96	14.22	14.42
97	15.96	16.2
98	11.2	11.45
99	14.1	14.42
100	14.12	14.12

FIG – 10:MENTAL FORAMEN - DISTANCE FROM LOWER BORDER OF MANDIBLE - MAXIMUM DISTANCE

FIG – 11:MENTAL FORAMEN - DISTANCE FROM LOWER BORDER OF MANDIBLE - MINIMUM DISTANCE

It has been observed that the maximum distance of mental foramen from lower border of mandible on both sides is 17.1 mm in specimen 41 (Fig -10).

The minimum distance recorded was 9.4 mm on both sides in specimen 69 (Fig -11).

The foramen was absent on both sides in specimen 55 (Fig -12).

Situational variability of mental foramen and Accessory foramen:

The position of the mental foramen in relation to lower teeth was studied in hundred mandibles on both sides and the collected data's are tabulated.

FIG -12 : BILATERALLY ABSENT MENTAL FORAMEN

Table 13. Situational variability of the mental foramen and Accessory foramen

Specimen no	Situational variability -types		Accessory foramen	
	Rt	Lt	Rt	Lt
1	4	4	-	-
2	4	4	-	-
3	4	4	-	-
4	3	3	-	-
5	4	4	-	-
6	4	4	-	-
7	4	4	-	-
8	5	5	-	-
9	3	3	-	-
10	4	4	-	-
11	4	4	-	-
12	3	3	-	-
13	4	4	-	-
14	4	4	-	-
15	3	3	-	-
16	4	4	-	-
17	3	3	-	-
18	4	4	-	-
19	4	4	-	-
20	5	5	-	-
21	4	4	-	-
22	3	3	-	-
23	4	4	-	-
24	3	3	-	-
25	4	4	-	-

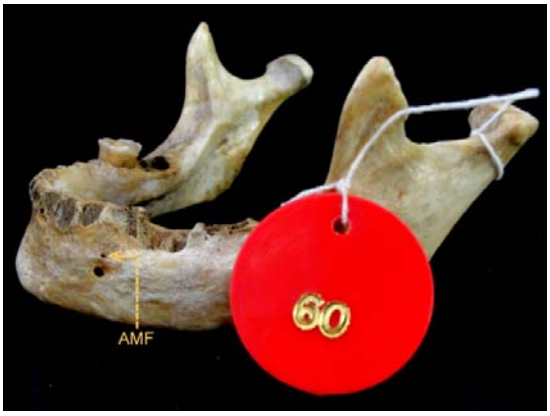
Specimen no	Situational variability- types		Accessory foramen	
	Rt	Lt	Rt	Lt
26	4	4	-	-
27	4	4	-	-
28	3	3	-	-
29	4	4	-	-
30	3	3	-	-
31	4	4	-	-
32	4	4	-	-
33	4	4	-	-
34	3	3	-	-
35	4	4	-	+++
36	4	4	-	-
37	3	3	-	-
38	4	4	-	-
39	4	4	-	-
40	3	3	-	-
41	4	4	-	-
42	4	4	-	-
43	4	4	-	-
44	4	4	-	-
45	5	5	-	+
46	4	4	-	-
47	4	4	-	+++
48	3	3	-	-
49	4	4	-	-
50	4	4	-	-

Table 14. Situational variability of the mental foramen and Accessory foramen

Specimen no	Situational variability -types		Accessory foramen	
	Rt	Lt	Rt	Lt
51	3	3	-	-
52	4	4	-	-
53	4	4	-	-
54	3	3	-	-
55	-	-	-	-
56	4	4	-	-
57	4	4	-	-
58	3	3	-	-
59	5	5	-	-
60	3	3	-	+
61	4	4	-	-
62	4	4	-	-
63	3	3	-	-
64	4	4	-	-
65	3	3	-	-
66	4	4	-	-
67	4	4	-	-
68	4	4	-	-
69	4	4	-	-
70	4	4	-	-
71	4	4	-	-
72	4	4	-	-
73	3	3	-	-
74	4	4	-	-
75	4	4	-	-

Specimen no	Situational variability-types		Accessory foramen	
	Rt	Lt	Rt	Lt
76	4	4	-	-
77	4	4	-	-
78	4	4	-	-
79	4	4	-	-
80	3	3	-	+
81	4	4	-	-
82	4	4	-	-
83	4	4	-	-
84	5	5	-	-
85	3	3	-	-
86	4	4	-	-
87	4	4	-	-
88	3	3	-	-
89	4	4	-	-
90	4	4	-	-
91	3	3	+	-
92	4	4	-	-
93	4	4	-	-
94	3	3	-	-
95	4	4	-	-
96	4	4	-	-
97	3	3	-	-
98	4	4	-	-
99	4	4	-	-
100	4	4	-	-

FIG -13 : ACCESSORY MENTAL FORAMEN (AMF) ON LEFT SIDE



It is observed from the above data that the relation of mental foramen with the lower teeth is predominantly of type – 4 (below 2^{nd} pre molar) on both sides.

Accessory foramen is present only on left side in specimens 45, 60, 80 (Fig -13).

Multiple accessory foramen is found in specimens 35 and 47 (Fig -14).

Specimens 91 (Fig -15) showed presence of Accessory foramen on right side only.

FIG -14 : ACCESSORY MENTAL FORAMEN (AMF) - MULTIPLE ON LEFT SIDE

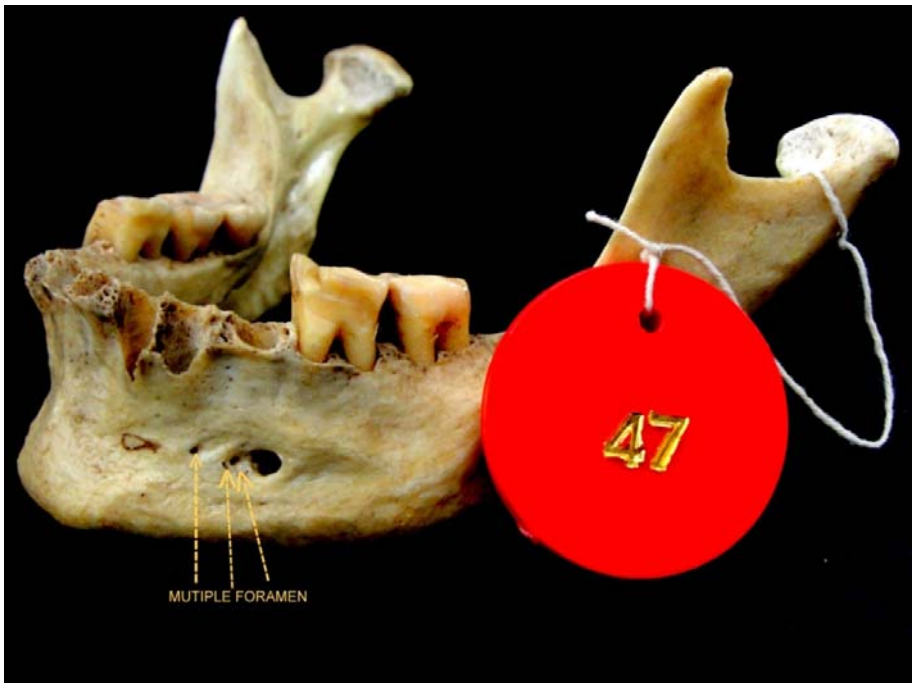
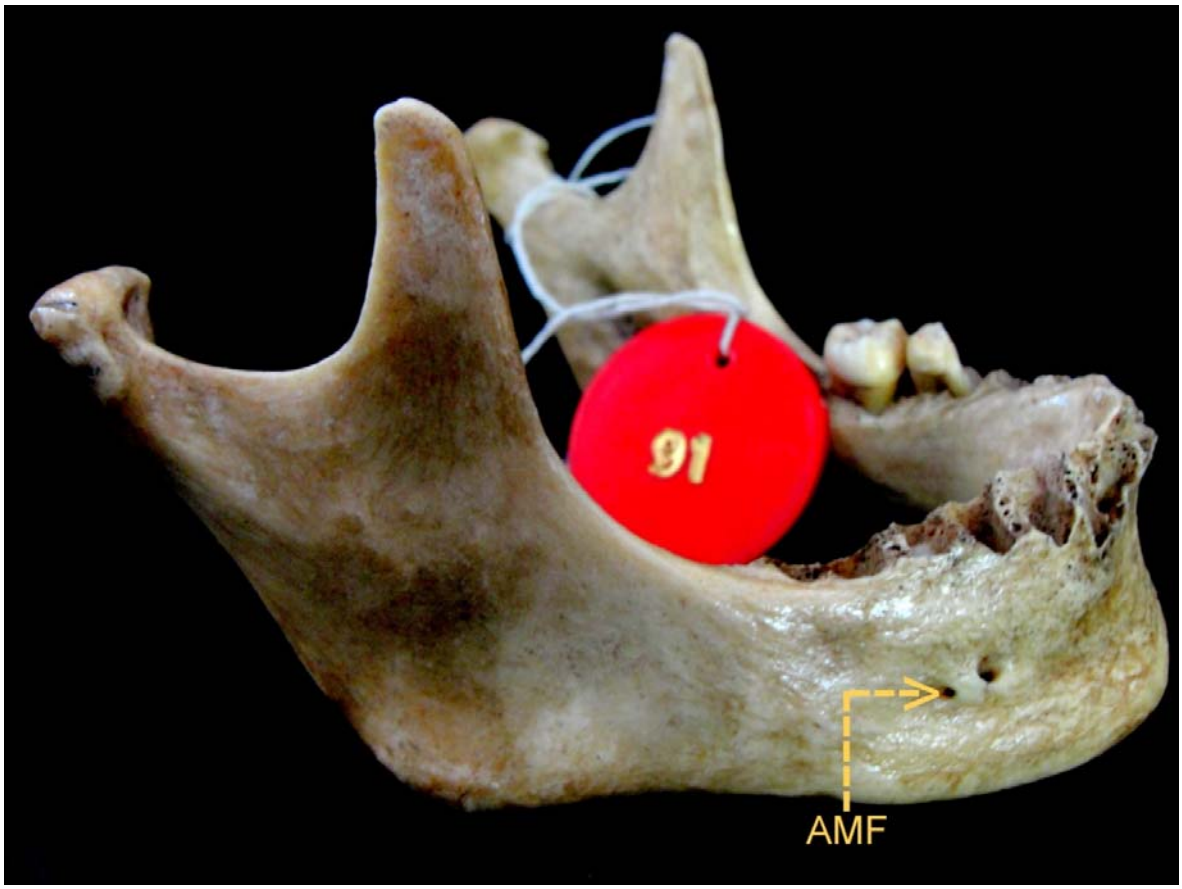


FIG -15 : ACCESSORY MENTAL FORAMEN (AMF) ON RIGHT SIDE



DISCUSSION

Analyzing the morphological characteristics of a bone is important for clinicians and anthropologists. Sound bone is difficult to obtain as the bone quality deteriorates over time due to various factors. Most of the bones in the human body are rarely found intact. The mandible is the strongest bone in the human body and persists in a well-preserved state longer than any other bone. Therefore, mandibular characteristics are extremely useful for several purposes.

Bigonial width

In the present study, bigonial width ranges from 75.5 mm to 106.7 mm with a mean value of 90.04 mm. Bigonial width is influenced by eversion or inversion of the gonial angle. Eversion of the gonial angle leads to increased bigonial width and inversion leads to decreased bigonial width.

Earlier Lockhart [1965][27], Parikh [1999][35], Nandy Apurba [2010][32] observed that the eversion of gonial angle is characteristic of male and inversion is that of female.

In the present study, fifty mandibles having bigonial width greater than the mean value are considered as males and forty eight mandibles having lesser bigonial width are regarded as females. Two mandibles having values equal to the mean value remain undecided.

Hence with bigonial width, 50% mandibles are found to be males and 48% to be females which differs from the study of Ongkana N, Sudwan [2010][34] who reported 50% females and 50% males by their study.

Height of the ramus

Morant et al[1936][31], Martin [1936][30] and Hrdlicka [1940][21] found that the sexual differences were highest in the height of the ramus.

The ramus of the mandible is subjected to greater stress by the process of mastication than any other bone of the skull. As the masticatory forces exerted are different for males and females, the size of the ramus differs in both sexes.

Earlier Saini V, Srivastava [2011][40] reported a mean ramus height of 57.56 mm and mandibles with ramus height above the mean value can be considered as males and below the mean value as females.

In the present study, the height of the ramus on both sides ranges from 45.2 mm to 73.8 mm , with a mean value of 59.9 mm which is greater than the mean value observed by Saini V and Srivastava.

With the help of this parameter alone, out of hundred mandibles forty nine are found to be male and forty one to be female and ten remain undecided.

Maximum breadth of the ramus

During growth, mandibular ramus and condyle are associated with greatest morphological changes in size and remodelling, so said to be most dimorphic.

In the present study, maximum breadth of the ramus ranges from 30.4 mm to 47.2 mm with a mean value of 39.21 mm on right and left sides. This mean value was less than

the value observed by Saini V , Srivastava [2011][40] who reported a mean value of 41.58 mm in their study.

Earlier Malik [1969][29], Surendranath [1989][49] , Parikh [1999][35], Nandy Apurba [2010][32] described that greater breadth of the ascending ramus was seen in males. In our study , fifty mandibles with values greater than mean are said to be males and forty nine with lesser breadth are said to be females and one is left undecided.

Similarly Brothwell [1981][4] also observed that ascending ramus is longer and broader in males than females.

Minimum breadth of the ramus

In the present study, it is observed that the minimum breadth of the ramus ranges from 24.1 mm to 40.3 mm with a mean value of 30.5 mm on both sides. This mean value coincided with the mean value of 30.47 mm reported by Saini V ,Srivastava [2011][38].

By this parameter, forty six mandibles are found to be males and fifty to be females and four remain undecided.

With mandibular ramus height, maximum ramus breadth and minimum ramus breadth, 85% classification accuracy was reported by Giles [1964][14] in American whites and Negroes. But in this study which is conducted in South Indian population, only 69% accuracy is obtained which is less when compared to that of Giles.

Symphyseal height

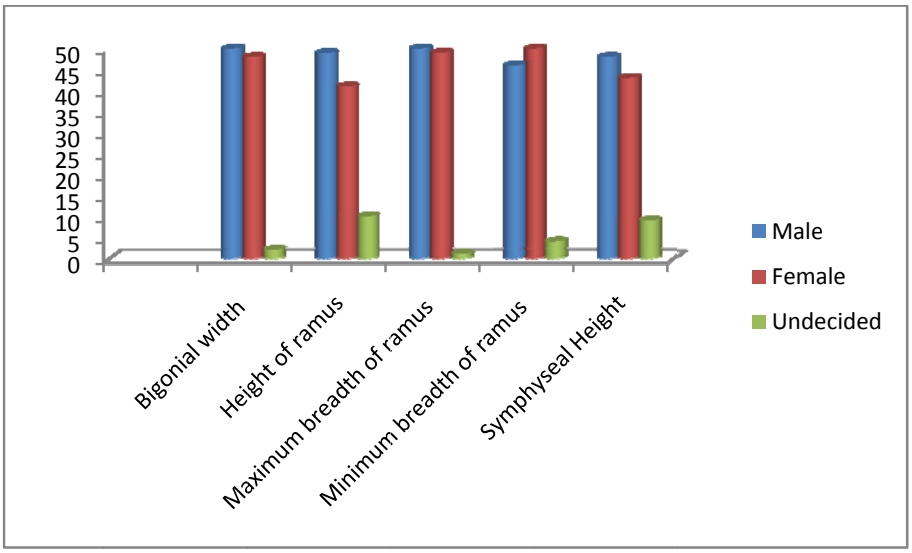
Malik [1969][29], Surendranath [1989][49] , Parikh [1999][35], Nandy apurba [2010][32] reported that males have greater symphyseal height and females have relatively lesser symphyseal height.

In the present study, the symphyseal height ranges from 16.4 mm to 30.6 mm with a mean value of 22.99 mm. From this study, out of hundred mandibles, forty eight are found to be males and forty three to be females and nine remain undecided as reported earlier by Malik [1969][29] and Surendranath [1989][49].

Table 1 : Parameters of mandible

S.No	Parameter	Range		Average mean	Male	Female	Undecided
		Minimum (mm)	Maximum (mm)				
1.	Bigonial width	75.5	106.7	90.4	50	48	2
2	Height of the ramus	45.2	73.8	59.9	49	41	10
3	Maximum breadth of the ramus	30.4	47.2	39.21	50	49	1
4	Minimum breadth of the ramus	24.1	40.3	30.5	46	50	4
5	Symphyseal Height	16.4	30.6	22.99	48	43	9

Diag : 1 Parameters of mandible



From table - 1 it is observed that the mandibles with undecided sex are 2% , 10% , 1%, 4% and 9% using bigonial width , height of the ramus , maximum breadth of the ramus, minimum breadth of ramus and symphyseal height respectively (Diag – 1) .

Mental foramen

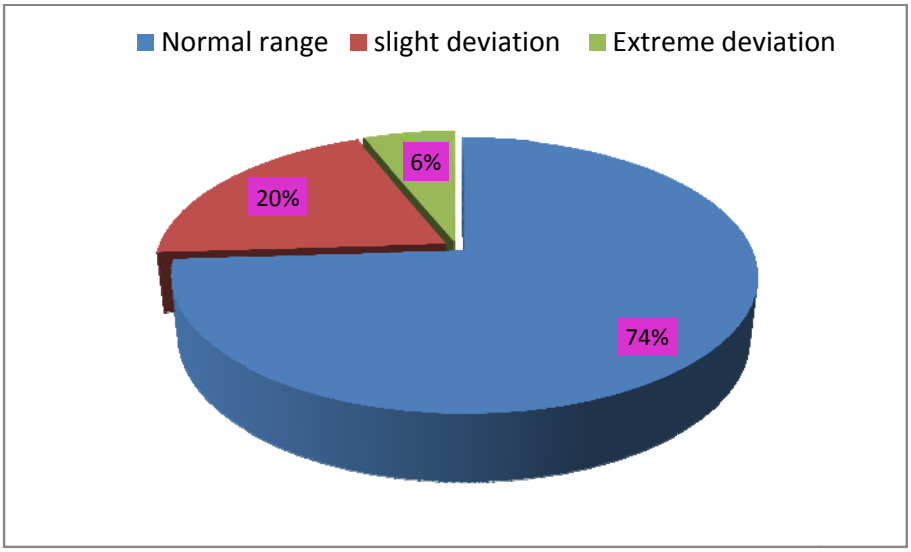
Recent advances in clinical dentistry like dental implants and orthognatic surgeries have highlighted the clinical significance of the mental foramen.

The restoration of form and function without damaging important anatomical structures is the fundamental goal of all surgeries. Hence identification of mental foramen and preservation of the mental neuro vascular bundle is of utmost importance in periapical surgery, implant surgery, maxillofacial surgery and orthognathic procedures.

Normally the mental foramen is located at a distance of 13 - 15 mm from the lower border of the mandible.

In our study, the distance of the mental foramen from the lower border of the mandible ranges from 9.4 mm to 17.1 mm

Diag : 2 Distance of mental foramen from the lower border of mandible



on the right side and 9.5 mm to 17.2 mm on the left side.

On the right side, seventy three mandibles are found to be within normal range, fourteen below the normal i.e. close to the lower border and twelve above the normal i.e. close to the alveolar border.

On the left side, seventy four are found to be within normal range, fifteen below the normal i.e. close to lower border and ten above the normal i.e. close to alveolar border. The difference observed between both sides is found to be insignificant.

From this, it is observed that, 74 % of mandibles lies within the normal range and 20% of mandibles shows slight deviation from the normal range whereas 6% shows extreme deviation (Diagram 2) .

This knowledge helps to identify the mental foramen in relation to the apex of the root canal. Therefore the post- operative complications arising due to inflammation of the apical tissue by instrumentation can be reduced.

The situation of the mental foramen with respect to lower

teeth or interdental space among different population is given below.

SITUATIONAL VARIABILITY OF MENTAL FORAMEN

FIG – 16: TYPE -4

FIG – 17: TYPE – 3

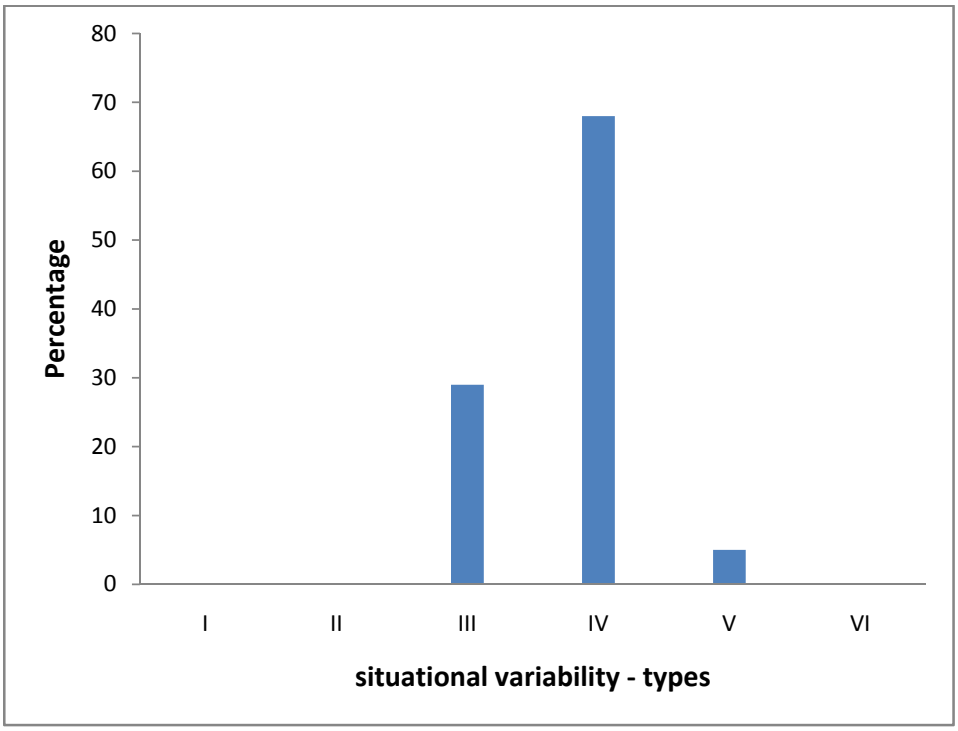
FIG – 18: TYPE - 5

Table : 2 Position of the mental foramen in relation to lower teeth in different population.

	Location		Type 1	Type 2	Type 3	Type 4	Type 5	Type 6
Siddiqui AU (2011)[44]	Western India	R	1.07%	6.45%	41.93%	44.08%	6.45%	0
		L	1.07%	8.6%	35.48%	46.23%	8.6%	0
Ilayaperuma et al (2009)[24]	Srilanka				26.47%	52.94%		
Yesilurt (2008)[51]	Turkey				R34.3% L 25%	R 55.7% L 61.4%		
Fabian (2007)[8]	Tanzania					45%	35%	
Kim et al (2006)[26]	Korea				26.8%	64.3%		
Gingor (2006)[15]	Turkey				71.5%	22.4%		
Ngeow (2003)[33]	Malaysia				19.6%	69.2%		

In the present study, it is observed that, the most common positions of the mental foramen in relation to lower teeth are below the second premolar [type- 4 (Fig -16)] in 68% of

Dig : 3 Position of the mental foramen in relation to lower teeth in different population



mandibles, between the premolars [type-3 (Fig -17)] in 29% of mandibles and behind the second premolar [type- 5 (Fig -18)] in 5% on both sides. Types 1, 2, 6 are not observed in our study. (Diag 3)The observations made in the present study differs from the previous studies shown in Table 2.

These variations indicate towards the variational mandibular dynamics of the population under consideration. Many of the differences can also be attributed to the variability in the chewing habits of different populations, leading to differential development of the mandible. The relative position of the mental foramen may be influenced by factors like age, race and ethnicity.

Thus the trauma to the mental neurovascular bundle that may result in paresthesia or anaesthesia can be avoided by accurate localization of the mental foramen.

Accessory mental foramen

Unlike non human primates, the mental foramen is usually single in humans, but accessory foramina have also been

recorded. It has been suggested that separation of the mental nerve into several fasciculi earlier than the formation of the mental foramen until the 12th gestational week could be a reason for the formation of accessory mental foramen.

In our study, it is observed that 4% mandibles have double foramen,1% have triple and four mental foramen which is similar to the study of Gerhenson et al [1986][13]who reported double foramen in 4.6%, triple in 0.7% ,four in 0.1% respectively.

The presence of nerve fibers in accessory foramina may result in ineffective inferior alveolar nerve block. Recurrence of pain after peripheral neurectomy done for trigeminal neuralgia is due to failure to identify mental nerve branch coming out of accessory foramen. Blood vessels present in accessory foramina can be a cause of intraosseous hemorrhages during implant procedures.

The possible role of accessory foramina and their neurovascular contents in the spread of tumors of this region has also been recognized by K. Fanibunda and N.S Mathews [1999][9].Hence it is

important to exclude tumour spread in this region prior to undertaking the conservative rim resection procedure.

Absent mental foramen

Absent mental foramen is an extremely rare anatomic variation. Infact, man is the only primate known to have agenesis of the mental foramen. The frequent reasons for absence may range from atrophy, post traumatic fibrosis, osteoblastic hyperplasia, geriatric bony resorption or congenital agenesis.

In our study bilateral absence of mental foramen was observed in specimen 55.

Till now, only four cases of unilateral absence and a single case of bilateral absence by Hasan T, Fauzi M [2010][19] has been reported . The frequency of unilateral absence of the mental foramen is very rare; ranges from less than 0.02% [9] to 0.47% ; while the frequency of bilateral absence is statistically negligible.

Since the mental foramen marks the exit of mental nerves and vessels (the sensory supply of the lower lip-chin area), it's

absence would mean no outlet for this neurovascular bundle and probable sensory alterations in that area. Hence, the subjects may present with some neurosensory disturbance in the mental region or around lips due to this rare condition. Clinical implications would include ineffective mental block in anesthesia.

Thus identifying all the variations by a prior digital Computed Tomography Scan will reduce the incidence of post procedural paralytic and hemorrhagic complications in the mental region, thereby significantly reducing the morbidity.

SUMMARY AND CONCLUSION

Hundred human dry mandibles were studied morphologically. The morphometric data's were analysed and the following conclusions were arrived .

- Bigonial width, height of the ramus, maximum breadth of the ramus, minimum breadth of the ramus and the symphyseal height showed significant sexual dimorphism.
- 50% of the mandibles showed everted gonial angle with bigonial width more than the mean value of 90.4 mm and 48% showed inverted gonial angle with bigonial width less than the mean value of 90.4 mm.
- Only 3% of the mandibles cannot be sexually categorised considering bigonial width and maximum breadth of the ramus whereas 23% could not be categorised using height of the ramus, minimum breadth of the ramus and symphyseal height.
- Height of the ramus, maximum breadth of the ramus minimum breadth of the ramus on right and left side

showed insignificant difference.

- In 74 % mandibles, the distance of the mental foramen from the lower border of the mandible was found to be within the normal range of 13–15 mm on both sides. Only 6% showed extreme deviation with a minimum of 9.4mm and a maximum of 17.1 mm.
- Accessory foramen was found on left side in five specimens (35,45,47,60,80) and on right side in only one specimen (91).
- Bilaterally absent mental foramen, an extremely rare variation was seen in specimen fifty five (55).

This study may be helpful to the maxillofacial surgeons and anthropologists for identification of different populations . This study also highlights the unnoticed variations of the mental foramen which is essential to prevent the neurovascular complications in the mental region.

Thus the study of morphology of the mandible is a possible contribution to the further research among the dentists, orthopedicians and anatomists.

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				MASTER CHART										
									Mental Foramen					
Specimen No	Bigonial width (mm)	Height of the ramus (mm)		Maximum Breadth of the Ramus (mm)		Minimum Breadth of the Ramus (mm)		Symphyseal height (mm)	Distance from lower Border of mandible (mm)		Situational Variability Types		Accessory Foramen	
	Mean =90.4mm	Mean =59.9mm		Mean =39.21mm		Mean =30.5mm		an = 22.99r	Normal = 13-15mm					
		Rt	Lt	Rt	Lt	Rt	Lt		Right	Left	Rt	Lt	Rt	Lt
1	106.7	61.2	61.2	41.4	41.1	35.2	35.2	24.4	14.97	15.14	4	4	-	-
2	94.2	62.1	62.1	42.3	42.3	36.2	36.2	24.2	14.4	14.53	4	4	-	-
3	84.1	56.3	56.3	37.4	37.4	26.2	26.2	19.3	14.22	13.5	4	4	-	-
4	92.3	66.2	66.2	40.2	40.2	33.2	33.2	24.2	14.11	14.31	3	3	-	-
5	88.1	68.1	68.1	37.4	37.4	27.3	27.3	26.2	14.93	14.93	4	4	-	-
6	81.2	66.3	66.3	41.11	41.11	28.2	28.2	24.4	12.34	12.35	4	4	-	-
7	81.1	57.2	57.2	45.6	45.6	34.6	34.6	21.8	14.75	14.35	4	4	-	-
8	82.2	58.2	58.2	38.1	38.1	29.2	29.2	20.2	14.12	13.88	5	5	-	-
9	94.1	60.6	60.6	38.01	38.01	39.2	39.2	25.4	12.56	12.8	3	3	-	-
10	82.3	45.2	45.2	34.4	34.4	37.8	37.8	22.9	15.8	15.9	4	4	-	-
11	91.2	62.2	62.2	41.6	41.6	31.8	31.8	24.6	13.4	13.28	4	4	-	-
12	85.1	49.4	49.4	35.6	35.6	28.8	28.8	20.4	14.8	14.5	3	3	-	-
13	98.2	54.1	54.1	45.2	45.2	38.4	38.4	18.8	14.22	13.2	4	4	-	-
14	81.3	58.3	58.3	36.2	36.2	26.2	26.2	19.3	13.5	13.6	4	4	-	-
15	75.5	55.4	55.4	30.4	30.4	24.8	24.8	19.8	14.8	14.9	3	3	-	-
16	80.2	56.1	56.1	37.9	37.9	25.1	25.1	19.7	11.53	11.13	4	4	-	-
17	94.1	60.2	60.2	42.5	42.5	38.9	38.9	24.2	14.22	13.5	3	3	-	-
18	93.2	60.3	60.3	39.12	39.12	25.2	25.2	24.1	13.2	13.4	4	4	-	-
19	82.4	59.5	59.5	43.8	43.8	47.2	47.2	23.1	14.1	12.4	4	4	-	-
20	83.1	52.2	52.2	35.2	35.2	26.8	26.8	21.7	15.2	14.8	5	5	-	-
21	88.8	54.1	54.1	38.2	38.2	25.4	25.4	16.4	14.3	14.3	4	4	-	-
22	84.2	51.8	51.9	37.1	37.1	28.4	28.4	22.2	12.8	12.8	3	3	-	-
23	82.1	62.2	62.2	34.2	34.2	30.6	30.6	24.4	12.6	12.6	4	4	-	-
24	95.3	61.4	61.4	43.4	43.4	39.4	39.4	24.3	15.8	14.9	3	3	-	-

Specimen No	Bigonial width (mm)	Height of the ramus (mm)		Maximum Breadth of the Ramus (mm)		Minimum Breadth of the Ramus (mm)		Symphyseal height (mm)	Mental Foramen					
									Distance from lower Border of mandible (mm)		Situational Variability Types		Accessory Foramen	
		Mean =59.9mm		Mean =39.21mm		Mean =30.5mm			Normal = 13-15mm					
	Mean =90.4mm	Rt	Lt	Rt	Lt	Rt	Lt	an = 22.99r	Right	Left	Rt	Lt	Rt	Lt
25	81.2	59.4	59.5	41.6	41.6	26.2	26.2	23.2	13.45	11.9	4	4	-	-
26	93.2	62.1	62.1	40.4	40.4	33.8	33.8	27.8	14.2	14.2	4	4	-	-
27	92.2	59.6	59.2	38.2	38.2	24.9	24.9	24.4	14.9	14.8	4	4	-	-
28	81.3	54.5	54.5	37.1	37.1	28.2	28.2	22.3	13.5	12.12	3	3	-	-
29	82.1	55.2	55.2	42.3	42.3	34.9	34.9	23.4	13.7	14.7	4	4	-	-
30	102.8	66.1	66.1	42.9	42.9	34.8	34.8	26.7	13.12	13.45	3	4	-	-
31	82.7	55.2	55.2	43.1	43.1	28.2	28.2	20.24	12.82	13.22	4	4	-	-
32	100.8	58.2	58.2	38.2	38.4	34.8	34.8	18.8	13.6	13.5	4	4	-	-
33	88.6	58.4	58.4	36.9	36.9	27.4	27.4	18.9	14.9	14.9	4	4	-	-
34	95.4	57.2	57.2	37.9	37.9	28.8	28.8	25.4	13.8	14.2	3	3	-	-
35	83.2	59.5	59.5	42.2	42.2	34.2	34.2	18.6	11.52	11.48	4	4	-	+++
36	93.4	73.8	73.8	41.2	41.2	35.2	35.2	24.6	12.5	12.5	4	4	-	-
37	99.3	65.6	65.6	34.2	34.2	28.2	28.2	18.6	15	15	3	3	-	-
38	86.3	54.6	54.6	40.9	40.9	26.2	26.2	23.2	13.2	13.2	4	4	-	-
39	99.3	62.7	62.7	40.6	40.4	36.4	36.4	24.6	15.8	14.65	3	3	-	-
40	82.2	55.2	55.2	33.2	33.2	25.7	25.7	22.4	14.2	14.2	4	4	-	-
41	92.4	62.1	62.1	36.2	36.2	30.45	30.45	27.2	17.1	17.2	4	4	-	-
42	89.1	55.5	55.5	32.2	32.2	28.2	28.2	19.8	14.25	14.25	4	4	-	-
43	96.5	67.3	67.3	41.4	41.4	32.8	32.8	24.4	16	17.1	4	4	-	-
44	79.2	47.2	47.2	37.2	37.2	24.8	24.8	18.5	14.2	14.2	5	5	-	-
45	101	65.1	65.1	42.4	42.4	33.6	33.6	29.2	14.5	15.5	4	4	-	+
46	89.2	59.4	59.5	40.2	40.2	25.2	25.2	44.7	13.8	14.2	3	3	-	-
47	94.3	70.4	70.1	43.4	43.4	34.2	34.2	26.8	13.52	13.52	4	4	-	+++
48	83.4	49.2	49.1	38.1	38.1	26.2	26.2	21.7	14.8	14.7	4	4	-	-
49	92.1	64.3	64.3	42.4	42.4	35.4	35.4	24.5	15.4	15.8	4	4	-	-

Specimen No	Bigonial width (mm)	Height of the ramus (mm)		Maximum Breadth of the Ramus (mm)		Minimum Breadth of the Ramus (mm)		Symphyseal height (mm)	Mental Foramen					
									Distance from lower Border of mandible (mm)		Situational Variability Types		Accessory Foramen	
		Mean =59.9mm		Mean =39.21mm		Mean =30.5mm			Normal = 13-15mm					
	Mean =90.4mm	Rt	Lt	Rt	Lt	Rt	Lt	an = 22.99r	Right	Left	Rt	Lt	Rt	Lt
50	93.2	63.3	63.1	40.2	40.2	36.8	36.8	23.1	14.9	15.2	3	3	-	-
51	95.5	69.4	69.2	45.2	45.2	32.2	32.2	24.8	13.8	15.82	4	4	-	-
52	97.2	66.2	66.1	44.3	44.3	31.9	31.9	24.5	13.52	13.62	4	4	-	-
53	90.1	54.4	54.3	40.1	40.1	26.2	26.2	21.5	13.22	13.32	4	4	-	-
54	79.6	50.6	50.2	34.6	34.6	24.8	24.8	21.2	13.2	13.4	3	3	-	-
55	84.4	59.6	59.4	37.6	37.6	31.9	31.9	23.14	-	-	4	4	-	-
56	100.3	71.5	71.5	34.2	34.2	24.1	24.1	27.2	15.82	14.52	4	4	-	-
57	89.3	58.2	58.3	38.1	38.1	25.6	25.6	21.23	13.92	13.82	4	4	-	-
58	84.6	58.5	58.5	38.4	38.6	26.2	26.2	18.12	14.2	14.5	3	3	-	-
59	99.4	70.6	70.2	46.2	43.2	34.6	34.6	28.23	14.8	14.4	5	5	-	-
60	87.7	58.4	58.4	37.7	37.7	30.53	30.53	23.41	13.45	13.45	3	3	-	+
61	95.8	63.8	63.8	42.2	42.2	38.2	38.2	24.15	14.82	14.5	4	4	-	-
62	89.1	58.3	58.3	38.4	38.4	24.8	24.8	18.23	14.12	14.3	4	4	-	-
63	88.4	58.4	58.4	36.8	36.8	27.9	27.9	20.23	12.4	13.24	3	3	-	-
64	90	65	65	31.9	31.9	28.2	28.2	23.1	13.4	13.6	4	4	-	-
65	97.3	62.7	62.7	41.7	41.7	36.2	36.2	24	11.3	11.3	3	3	-	-
66	87.6	50.2	50.2	37.2	37.2	27.4	27.4	22.2	14.8	14.6	4	4	-	-
67	97.8	64.3	64.3	42.1	42.1	35.2	35.2	27.6	16.2	15.9	4	4	-	-
68	81.2	57.2	57.2	35.2	35.2	24.9	24.9	23.1	9.8	12.2	4	4	-	-
69	77.4	50.3	50.3	37.1	37.1	28.3	28.3	21	9.4	9.5	4	4	-	-
70	83.2	59.5	59.5	42.6	42.6	27.2	27.2	24.5	13.6	13.6	4	4	-	-
71	92.4	63.3	63.3	41.9	41.9	32.8	32.8	25.2	14.2	13.9	4	4	-	-
72	98.6	67.2	67.2	47.2	47.2	40.3	40.3	25.2	13.3	16.2	4	4	-	-
73	98.1	64.1	64.1	44.2	44.2	34.6	34.6	24.4	14.2	14.2	3	3	-	-
74	79.3	62.1	62.1	37.7	37.7	39.6	39.6	23.1	13.2	13.34	4	4	-	-

Specimen No	Bigonial width (mm)	Height of the ramus (mm)		Maximum Breadth of the Ramus (mm)		Minimum Breadth of the Ramus (mm)		Symphyseal height (mm)	Mental Foramen					
									Distance from lower Border of mandible (mm)		Situational Variability Types		Accessory Foramen	
		Mean =59.9mm		Mean =39.21mm		Mean =30.5mm			Normal = 13-15mm					
	Mean =90.4mm	Rt	Lt	Rt	Lt	Rt	Lt	an = 22.99r	Right	Left	Rt	Lt	Rt	Lt
75	97.4	64.3	64.3	34.1	34.1	36.2	36.2	23.2	13.1	13.2	4	4	-	-
76	96.5	68	68	33.3	33.3	27.2	27.2	17.6	16.3	14.9	4	4	-	-
77	87.1	58.4	58.4	32.6	32.6	28.9	28.9	18.2	13.95	13.19	4	4	-	-
78	80.5	50.2	50.2	35.5	35.5	26.2	26.2	21.8	11.51	13.82	4	4	-	-
79	103.2	59.4	59.4	45.8	45.8	32.2	32.2	27.3	13.94	13.54	4	4	-	-
80	98.2	54.2	54.2	40.5	40.5	25.4	25.4	20.2	13.8	13.4	3	3	-	+
81	87.4	52.3	52.3	32.2	32.2	26.2	26.2	21.2	14.16	14.14	4	4	-	-
82	92.3	64.2	64.2	45.2	45.2	36.2	36.2	24.2	14.12	13.82	4	4	-	-
83	92.1	64.1	64.1	43.2	43.2	35.4	35.4	25.3	13.2	14.4	4	4	-	-
84	95.4	66.2	66.1	44.8	44.8	34.6	34.6	27.1	13.86	13.14	5	5	-	-
85	99.3	68.3	68.1	31.6	31.6	28.1	28.1	17.6	13.48	13.2	3	3	-	-
86	87.2	61.2	61.2	34.9	34.9	25.8	25.8	18	14.82	14.32	4	4	-	-
87	98.3	61.1	61.1	45.6	45.6	37.8	37.8	26.2	13.3	13.4	4	4	-	-
88	91.62	65.2	65.2	43.7	43.7	39.2	39.2	29.1	10.6	10.7	3	3	-	-
89	100.2	66.2	66.2	40.82	40.82	27.6	27.6	25.2	14.7	14.98	4	4	-	-
90	95.2	68.2	68.2	42.6	42.6	39.3	39.3	26.1	14.2	14.5	4	4	-	-
91	86.4	59.4	59.4	45.8	45.8	28.4	28.4	23.1	13.12	13.45	3	3	+	-
92	93.3	65.4	65.4	44.32	44.32	38.4	38.4	26.3	13.34	13.14	4	4	-	-
93	86.3	57.4	57.5	36.2	36.2	26.7	26.7	22.2	13.38	14.38	4	4	-	-
94	97.1	62.2	62.3	43.3	43.3	32.8	32.8	30.6	13.92	13.24	3	3	-	-
95	96.1	59.8	59.6	31.3	31.3	34.8	34.8	20.2	13.32	13.52	4	4	-	-
96	94.2	53.2	53.2	34.8	34.8	30.49	30.49	20.1	14.22	14.42	4	4	-	-
97	85.2	50.8	50.8	36.3	36.3	25.7	25.7	22.4	15.96	16.2	3	3	-	-
98	100.4	61.4	61.5	44.8	44.8	39.6	39.6	26.3	11.2	11.45	4	4	-	-
99	98.2	62.2	62.5	41.2	41.2	34.8	34.8	27.4	14.1	14.2	4	4	-	-
100	88.6	63.4	63.4	36.2	36.2	36.2	36.2	18.4	14.12	14.12	4	4	-	-